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An analysis of the Spanish Science and Technology system

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Abstract

The lack of common objectives is harmful to display a dynamic innovation system, where universities-firms-governments walk together in the same way to accomplish a common objective: produce high levels of innovation that aim to enhance the competitiveness of European economy. The sharing of practices, attitudes, expectations, rules and values that enable the flow and the distribution of tacit knowledge and other ways of proprietary knowledge are essential to promote an innovation system coming from Educational Institutions. In this paper we offer a diagnosis of the Spanish Science and Technology System by making use of the normalized protocol for responsible partnering proposed by EIRMA (European Industrial Research Management Association) in 2009. Afterwards we build a SWOT analysis that can be of interest to University and Innovation policy makers in Spain. We suggest the use of the same tools to analyze what is happening in other contexts in order to find best practices that will lead us improve different systems.

Keywords: open innovation practices; Science and Technology system; EIRMA protocol; SWOT analysis

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1. Introduction

Some countries are characterized by the great number of scientific production and the lack of capacity for the creation of value in terms of innovation. This circumstance has a negative impact in the competitiveness of the country in the International context.

Innovations are a result of a process of development and learning that goes beyond the organizational barriers, from the scientific and technological developments up to those that appear from the interaction with other sources of knowledge. These interactions have the power to make dynamic capabilities appeared [1], [2], [3], [4] and this reality is directly related with the concept of relational capital and its positive influence over organizational innovation [5].

In this sense, we can stress that organizations in a certain environment can combine resources in order to establish networks that favor and stress some inter-organizational links, as it is proposed by regional and national innovation systems. In these systems the identification of agents and relationships [6] serve as a basis for the creation and spread of knowledge and greatly influence as a foundation for the development of innovation policies [7].

Therefore, to transform the scientific production in innovation requires of the creation of areas of interchange between the academia and the market [8] that promote the private and public initiatives for collaboration.

The dichotomy that we find in some parts of the European Science and Technology System showing high levels of scientific production and low levels in innovation and competitiveness, lead us to think that the relationships that the system maintain are not based in the sharing of objectives amongst the different agents that take part and this reality acts as a detractor element to establish a model where the university, the industry and the government collaborate to reach common objectives and this way build a system where efficiency is maximized, as it is proposed by the triple helix model [9].

In this paper by applying a Delphi method we have offered a realistic diagnosis of the interests that each agent being part of the Spanish Science and Technology system shows to this respect. By applying the EIRMA European Industrial Research Management Association protocol (2009) we will offer a diagnosis of the Spanish system that make serve as an example in the International context.

2. Method

We are going to use the inductive-deductive method based in the observation of the reality with the main objective to reach a generalized consensus, and if possible a model of behaviour. By making use of the Grounded Theory we have identified the different agents, analyzed interactions, studied the legal framework and afterwards we have realized interviews in deep with national experts in the University system.

The Grounded Theory allows us explaining the relations in the various human beings behaviours in a concrete field of study.

Although traditionally this methodology has been applied to sociological studies, there are some other areas of knowledge that have used it in innovation areas [10], the managerial areas [11], the director's perspective [12], the research in business organization [13], the creation of firms [14] or innovation systems [15].

[16] Affirms that the Grounded Theory is useful to do research in fields related with human behaviour in different organizations, groups and other social configurations. Since the context to create a science and technology system is a social process, we can affirm that this methodology can be applied to the study itself [15].

To develop this methodology we will develop case studies in deep by considering a representative sample of the agents that take part in the Science and Technology system of the country included in this work.

2.1. Study of the cases

From a study of cases we have identified different models for the promotion of collaborative practices amongst the University and firms. The study analyzed is composed by multiple cases. The selection of the cases has been provided according to two main criteria: the heterogeneity, all the selected cases are linked to the different Spanish Science and Technology sub-Systems; the exemplarity, the organizations we analyze in Spanish context are exemplar and take an active part in the development of a competitive science and technology system. Table 1 show the different cases analysed

Table 1: the cases selected for the research

Firm	Main activity
Bioserentia	Bio-tech incubator
Cotec Foundation	Business foundation composed by 69 public and private institutions with the main mission of promoting technological innovation in the firm and in the Spanish Society
Madrid Polytechnic University (UPM-Indra Project)	Academic Institution representing the public – private alliance, as shown in the 3O years of the Project UPM – Indra
Telefonica R+D	Spanish multinational located in the telecommunication industry
Tecnalia	Technology Center composed by 27 firms and 10 Public Institutions
Aimen (Association for the Research in Metals from the North-East)	Technological Center/ OTRI that comprises more than 100 firms and associations located in 14 different industries
Genoma Spain Foundation	Public Foundation for the promotion of biotechnology in Spain The sponsors are the Spanish Ministry of Science and Innovation the Ministry of Health and Social Affairs, Ministry of Industry, Tourism and Commerce, Environmental Ministry, the Government of Navarra and Andalucía

2.2. The need for coordination: the application of a Delphi analysis

The need of coordination is a pre-requisite to reach good results at Sience Systems. Coordination is the integration of organizational work in conditions of task and uncertain interdependence. The model of relational coordination puts emphasis in understanding the importance of coordinating the relationships and the dynamics of communication in organizations to reach best results [17]. From the model we can affirm that relational coordination is produced by providing a frequent communication of high quality, supported in shared objectives and knowledge and mutual respect.

The relational coordination model can be of interest to reach good results in organizations or organizational processes where high levels of task interdependence, uncertainty and time restrictions, and tacit knowledge are required. In the Science and Technology systems, these circumstances appear. In this paper we have applied the EIRMA (2009) protocol to analyse the degree of relational coordination amongst the various agents taking part in the system.

The application of the Delphi method has been developed based in two questionnaires. The first of all was elaborated in collaboration with Prof. Dr. Wim Vanhaverbeke and the OECD, by means of Koen DeBaker Director of STI/SDP. The second one, has been realized by considering the main guidelines of the Responsible Partnering protocol promoted by the European Commission and edited by the EIRMA in 2009 (European Industrial Research Management Association) in consensus with different Institutions of reference in the European R+D+r policy such as the EUA (European University Association), EARTO (European Association of Research and Technology Organizations) and ProTon Europe (European Knowledge Transfer Association).

With these surveys we would like to explore and describe the open innovation practices in public and private organizations by using public-private collaborative agreements and be able to explain the paradox of high degrees of scientific publications facing poor levels of innovation and competitiveness of the Spanish economy.

2.3. SWOT analysis

As main tool for the evaluation of the result we will be applying the SWOT analysis, acronym for Weakness, Threads, Strengths and Opportunities. This analysis has long been applied in prospective analysis over social and participative dynamics. From 1984, it has been each time more often used with applications in many different social and economic environments. This analysis has reached in the last years a great relevance in the strategic planning and in the diagnosis of needs. This methodology is useful when structural transformations are tried and to dynamite the change, elaborate new projects in action, and create collaboration networks [18].

[19], [20] used the SWOT analysis to analyze different industries. From their point of view, the origin of competitive advantages are found in the essential competencies of the organization, by being the strategic management a collective process of learning that helps to develop and explore distinctive competencies difficult to imitate by competitors.

This focus was re-affirmed by other authors as [21], [22] and [23], who emphasize the need to develop an organizational design that favours the flexible development and the recombination of these capabilities.

Therefore, the evolution of the SWOT analysis up to the concept of dynamic capabilities allows warranty its purpose to the proposed analysis.

To present the results the triple helix model [24] [9] has been used. This model has allowed the identification of the agents and the relations established amongst them. In figure 1 we present the model.

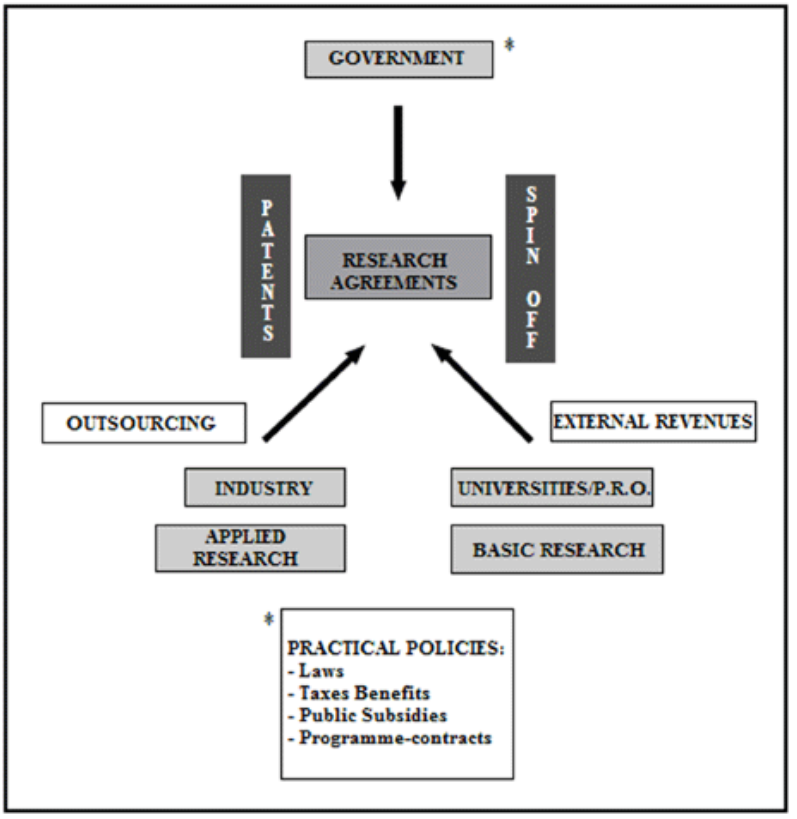

Fig. 1. The triple helix model applied to the Spanish model of Science and Technology

3. The results

The key aspect of a knowledge economy is a greater dependence in the intellectual capabilities more than in the natural resources, the work or capital. The integration with other resources allows obtaining improvements in the productive process, from the R+D to the production and the relationship with customers [25]. These changes have been reflected in an increase of the participation related to the GNP attributed to the intangible capital [26].

The essential competencies [27], [28] are not physical assets, but intangible assets, abilities and technologies [27] and they are routines, actions, operations that are of tacit nature, ambiguous and idiosyncratic [29], [30], [31] suggest that the competitive advantage of organizations is based in the established dynamic capabilities in the routines of high qualifications of the processes in organizations, conditioned by its history.

In this context, the Universities develop a main role to generate a knowledge economy, to act as the main agent in the generation of new competencies that answer to these premises in an economic model oriented to services.

This way, the political actions must be oriented to implement a model of innovation that adjusts as much as possible to a triple helix convergent model [9] where the three agents interlinking in the three agents of the system: universities, research centres, firms and Administrations.

The innovation policies in the EU reveal the effort realized in the last years to develop a strategy that favorites and promotes the establishing of innovation networks [32] or innovation dynamic capabilities [2], [33] with the purpose to stress the role that universities and transfer of knowledge centres develop in the innovation strategies of firms to be considered as an important source of knowledge and potential partners [34]. Next figure 2, summarises the main findings of the SWOT analysis

<table>
<tr>
<td rowspan="2">WEAKNESS</td>
<td>
STRATEGIC

Duplicity in the knowledge transfer structures (OTRIs, Innovation centers, technological platforms, etc)
An excess of atomization in the Spanish Science and Technology system form the geographical and disciplinary point of view
High rates of scientific production (position 9) and low levels of competitiveness (position 36)
A support for a lineal model of innovation in universities

CULTURAL

Universities seen as Institutions for the socialization of knowledge
A low interest of firms and research centers for patents
A lack of culture to understand the market of knowledge, which is an obstacle for the promotion
A lack of values centered in IP and industrial results
Perception that the collaborative and stable agreements are a barrier for innovation

RELATIONAL

Make firms be closer to the SCT to get public funds for R+D projects
The model firm – research center is sustained by a model of externalization of Works more than in the cooperation itself
Although there are formal channels to establish contacts, firms use mainly informal channels

</td>
<td>
STRATEGIC

A reduction of the R+D public funds
The changes in the system prioritize the IP as a tool for the reverse transfer
Universities see in the students a mechanism for the transfer of knowledge, facing patents, etc.
The channels to communicate R+D results are too endogamy for the scientific community, and therefore, they lack of access to firms
Contradiction in some aspects of the legal systems
The legislative reforms prioritize the index of impact of publications against the transfer of knowledge

MANAGERIAL

The market of knowledge is underdeveloped.
A system more centered around expenses more than in investments
Arbitrary commissions area applied to the selection of research projects at universities

CULTURAL

The low levels of R+D externalization of firms and stable agreements to promote the reverse transfer
A weak knowledge market, in part due to the lack of relevance for understanding the strengths of the system

</td>
<td rowspan="2">THREADS</td>
</tr>
</table>

STRENTHGS			OPPORTUNITIES
	STRATEGIC • Be a country showing high levels of scientific production (9º position) • Institutional interest in promoting the triple helix **MANAGERIAL** • Previous experiences in collaboration agreements • A proper legal framework to apply the *responsible partnering* • A good disposition of the implied parts to establish collaboration agreements by respecting the interests of the parts **RELATIONAL** • Top approach SMEs and big firms in the Spanish SCT • Good image of firms and OPIs on the joint benefits of the Ingenio program	**STRATEGIC** • Recent legal frameworks to promote horizontal and vertical cooperation • To benefit from the high scientific production to generate development (pre-competitive step) and innovation (basic application) **MANAGERIAL** • Agreement to promote public-private collaborations and the reverse transfer • To promote the concept of entrepreneurial university to support the creation of *spin off* **RELATIONAL** • An approach of OPIs to the entrepreneurial activity and vice-versa	

Fig. 2. Results of the SWOT analysis

From the empirical analysis that we have realized in this paper we have proofed that the results are limited since we have found a lack of both integration of capabilities or assignation of resources, and no networks of collaboration or renewal of new ways of thinking, nor capabilities to establish alliances, in the Spanish Science and Technology context.

A Science and Technology model that does not stimulus nor promotes the protection of the intellectual property, inhibits the process of conversion of knowledge from tacit to explicit [30], [35] since this last allows expressing in a coded way the technologies, products oriented to specific applications and this way, it promotes the establishing of bargaining objectives areas to promote the commercialization, the creation of an efficient knowledge market.

In this sense, we can find a situation where there is a lack of convergence of objectives in the different agents that take part in the systems, since they incentive more their individual objectives as it is stressed in the Agency theory [36], [37].

In the Spanish case, the lack of a common policy at a national level, makes prevail the particular interests of regions and besides, makes flow an incongruent normative that does not offer coherence in the Science and technology System since it does not promote de relationships amongst the agents.

Promoting a system that offers higher degrees in relational coordination could make a difference in the process of transfer of knowledge between one country and the countries it collaborates with.

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